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A METHODOLOGY/INSTRUMENTATION CONCEPT FOR TOTAL SYSTEM TEST AND EVALUATION OF ARMY DEVELOPMENTAL MATERIEL

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INTRODUCTION

The development of this methodology/instrumentation concept for system test and evaluation evolved from and rests upon a dendritic structured evaluation/effectiveness schema. This schema was developed in conjunction with Armor and Engineer Board methodology studies on Measures of Effectiveness - a study to define the measures of effectiveness for armor and engineer test items which would undergo Development Testing Service Phase, Functional Field Testing - a study which developed the testing required for selected systems to adequately address data requirements for assessing the Mission Performance Capability, and Test Design - a study to define the general design of developmental tests.

The Measures of Effectiveness (MOE) study concluded that many armor and engineer test items exhibited the same general MOE of System Performance (Mission Performance Capability), Parametric Performance (Physical Performance Characteristics), and Logistics and Training.

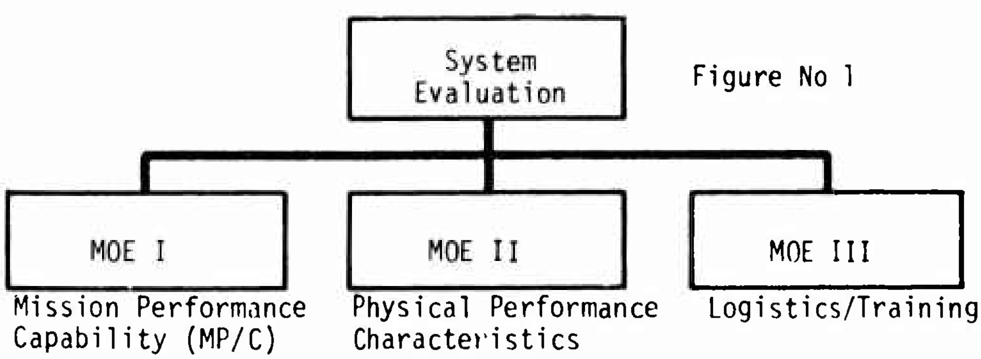

Figure No 1

For specific systems, these MOE, and others when appropriate, are further subdivided to a level where field test measurement can be accomplished. (See incl 1.) The lowest level of the dendritic provides the data elements required for the evaluation of the materiel. For each data element, a scoring curve is derived based on criteria, items classified Standard A, and military experience. The entire dendritic can then be quantified to allow for aggregate analysis, as well as analysis of criteria.

The purpose of this manuscript is not to address all of the previously mentioned techniques but is instead intended to describe the design considerations for system testing (functional field testing) and its interface with instrumentation (XM56 Hit-Kill Indicator - SIMFIRE).

The recurring MOE, Mission Performance Capability, requires that the test item be immersed in its simulated employment environment and its mission performance capability be evaluated, the pure materiel system being tested as a totality to the maximum extent possible. This testing is referred to as functional field testing. In theory, the parametric criteria, if all met, will translate into a system performance which will adequately accomplish the intended mission. In fact, this may or may not be true, therefore, the tester must not only test against the criteria but must test the criteria as well. In addition to answering the mission performance capability issues per se, the functional field tests allow for the achievement of a perspective on the criterion/parametric performance of a system thus setting off system performance attained against the parametric performance and allowing the impact of ability or failure to meet criteria to be adequately addressed.

The following provides an example of the type evaluation indicated above: Through parametric/criterion testing, it is determined that a test tank's achievable top speed cross-country is 15 mph and its acceleration is 22 fps, while a standard or comparison tank achieves 12 mph and 17.6 fps respectively. The criteria requires 20 mph and 27 fps. Without system data, it is difficult, if not impossible, to address the impact of the test item's failure to meet the above criterion while surpassing the performance of a standard item. However, functional field testing addressing vulnerability/survivability might indicate that the maneuverability/agility accruing to the test tank owing to its increased achieved (over the standard tank) cross-country speed and acceleration, enables it to avoid being hit by enemy AT fire 50 percent more often than the standard tank. The significant increase in survivability of the test tank over the standard, despite failure to meet the parametric speed and acceleration criteria, augers for minimizing the impact of this failure and would argue strongly for considering this parametric insufficiency inconsequential. If further analysis were desired with respect to hit avoidance with parametric performance at the criteria level, then this could be accomplished by computerized extrapolation or actual field testing by rigging a target vehicle with target and performance parameters equivalent to the tank and criteria respectively. It is recognized that cross-country speed and acceleration parameters also have fallout in areas other than vulnerability/survivability. However, they make their most direct, measurable, and quantifiable contribution to mission performance here; their other effects on such things as long-range movement rates of an armor unit being essentially muted out in a larger operational context.

FUNCTIONAL FIELD TEST DESIGN CONSIDERATIONS

There are certain general premises and principles which govern the application of functional field testing (FFT) techniques to any system. These methodology principles/guidelines provide the structural framework around which the particular functional test is designed. The actual design and substance of the FFT, as developed in accordance with the specified methodology concepts, then becomes a function of art and science. The ultimate test design must reflect the test developer's professional judgment and expertise as they relate to: definition of the mission spectrum and its reduction to essentials bearing upon the effectiveness of the tested system in its functional environment; development and precise definition of the data required to truly provide measures of the mission performance/capability of an item in the most comprehensive system context; identification and treatment of variables involved in the field testing; introduction of appropriate enemy action; and integration of mission reliability.

Whenever and wherever possible, a test materiel system should be evaluated in side-by-side testing with the standard item it is to replace, with competitive items or with proven systems of similar function/role. Comparison with a standard system is imperative if an effectiveness baseline or datum is to be established from which tested item effectiveness can be adjudged with perspective.

A. Mission Spectrum

Perhaps the most important consideration in test design is study, analysis, and development of the mission spectrum to be used in testing the item. The mission spectrum is absolutely pivotal to the entire test in that it dictates the demands to be placed on the system. If the mission spectrum and the associated demands are not sufficiently encompassing to include all critical demands, then the test may answer the wrong questions and omit vital considerations. The spectrum chosen must ensure inclusion of testing of the entire performance envelope of test and standard items. This is to assure that "additional capability" built into a new item is in fact tested properly and the item allowed to benefit from it. For example, if a new missile firing is purportedly especially capable of engaging attacking tanks at long (3,000 + meters) ranges with great accuracy, then the scope of mission (FFT) should include this. Conversely, the scope must also include "attack" exercises to surface potential burdens introduced by addition of the long-range missile capability.

Very careful study and analysis must be given to ensuring that the demands associated with the mission spectrum focus upon the materiel system and the immediate operator/crew-system relationship to the exclusion of all else. Keeping this consideration in mind will also help reduce the actual mission spectrum to manageable proportions.

For instance in the case of the tank, though units to which it is assigned receive a gamut of missions ranging from penetration, envelopment, to delay actions, mobile defense ad infinitum - the individual tank system itself does not "care." For it, confrontations with other tanks obtain in three basic modes: attack against other defending tanks; defense from selected positions against other attacking tanks; and surprise confrontations with other tanks where the two come upon one another unexpectedly and neither side is either attacking or defending (meeting engagements). These three modes place the spectrum of critical demands on the materiel system, demands which do not change throughout the entire unit mission spectrum.

In the case of tactical bridging, care would have to be exercised to include in the mission spectrum a variety of gap configurations/spans, near and far bank orientations, weather and light conditions, traffic mix and duration and mission duration. This is necessary to demonstrate the expected MP/C of the bridge as a function of its flexibility in adapting to the interactive factors of gap span/configuration, load and traffic requirements. Specifically, a bridge's ability to permit tailoring to varying gap/load requirements and to accomplish the mission of passing traffic under varying mission requirements must be allowed to surface and be evaluated in conjunction with a comparison system.

Because of the peculiarities involving the MP/C assessment of support systems, what would normally involve FFT for evaluation of MP/C, can be accomplished via a model or computer simulation of the MP/C test environment. The model would use actual parametric performance test data to satisfy input-variable data requirements where necessary. Support systems are ideally suited to the model simulation approach for evaluation of MP/C because effects of enemy action can be effectively ignored or blocked out, and because the component variables of their MP/C are readily isolatable, few in number, and take the form of basic parametric characteristics which are readily tested and quantified in a test environment.

B. Mission Performance/Capability Measures

The finer measures of MP/C will vary with materiel types, though the single, broad measure of Degree of Mission Accomplishment (DMA) is applicable to MP/C of virtually all systems. As the name implies, DMA assesses the degree to which a materiel system accomplishes its intended purpose in execution of any given mission of the mission spectrum.

Because of the broad nature of the DMA measure, it is often desirable and judicious to provide a finer measure of, and an additional perspective on, MP/C.

In the case of the tank, DMA assesses the tank's ability to attack an objective or defend a position under various enemy-friendly tank force ratios. The basic element of the measure - mission accomplishment - addresses in go-no-go fashion, the tank's ability to either successfully attack and seize the objective destroying all enemy or to hold a position and destroy all attackers. The aspect of "degree" enters in the evaluation by addressing the extent to which the tank accomplished these attack/defend go-no-go missions over the entire mission spectrum; that is, out of a total of 16 attack missions under varying force ratios, the tank may accomplish 12. Obviously, because of the go-no-go nature of DMA, and its broad orientation, it may not alone provide the necessary discrimination between the performance of two different type tanks. A finer measure of the "efficiency" of MP/C is required in order to provide another perspective. Both type tanks may have accomplished 12 of 16 attack missions, yet one or the other may have suffered less losses and "killed" more enemy tanks in so doing. Hence, in the case of the tank, kill/loss ratios achieved in the missions provide a finer measurement and another perspective on MP/C by allowing the efficiency of MP/C to be addressed as well as the broader and basic issue of DMA.

A truck whose mission is to support the Class V (ammunition) requirements of a tank battalion participating in a variety of combat actions has its DMA assessed on the basis of whether or not it can supply the required Class V within the time constraints established. If the trucks do not deliver all the required Class V within the time parameters, they receive a zero for mission accomplishment. "Degree" is assessed in terms of the truck's ability to deliver Class V over the entire spectrum of combat action Class V requirements and the rapidity with which it could be delivered. Again, as in the case of the tank, DMA provides an insight into the truck's ability or inability to supply a required amount, but does not credit the truck for delivering a percentage of the requirement. Assessment of MP/C from the standpoint of cargo hauled as a percentage of that required, provides another evaluative slant which permits achievement of perspective on the actual cargo support capability, given a mission is not accomplished.

C. Identification and Treatment of Variables

Normally, the major and dominant variable in the FFT is the effectiveness or system performance of the tested materiel system, and it is this variable that is allowed to "run free" - then measured in the context of other variables/parameters which are either constantized, randomized, or blocked out completely.

The final test design for an item should represent the optimization of the dynamic, but diametrically opposed interaction of maximization of materiel parametric performance parameters allowed to have play in the mission spectrum of FFT and minimization of introduction of variables. The object is to maximize the system orientation of the test and mission realism while maintaining statistically significant and reliable results through minimization of variables and bias and the exercise of rigid control. The exercise of rigid control in the conduct of FFT of MP/C is vitally important to filter out leadership influences, tactical judgments, and other bias sources.

Attainment of a 100-percent assurance that a materiel system will not be penalized or profit by the bias sources must be a goal of FFT. A mechanism for achieving this is the employment of controllers with all test, standard, and control items in order to limit crew/operator responses and actions along predetermined lines.

In FFT, it is absolutely imperative that operator/crew sets be rotated between test and standard/comparison items with which the test materiel is being compared. This rotation tends to randomize and smooth the effect of variances in human ability. The greater the number of crew sets/operators that can be rotated through test and standard items during FFT, the greater the assurance that the results achieved will reflect the performance of the materiel when and if it is placed in the hands of representative users.

In order that the crew/operator skills be as representative of those to be found Army-wide, crew/operators for the test should be drawn from a variety of units/locations.

The design of FFT must ensure that tests generating data pertaining to assessment of MP/C are replicated sufficiently to allow statistical analysis of the data at statistically significant and reliable levels. The specific number of replications required for a given test is a function of the number and nature of data element comparisons/assessments desired, the actual differentials in performance demonstrated in testing, confidence levels of evaluations and the specific statistical analytical technique employed; hence, the exact number of replications can only be determined on a case-by-case basis.

The following is briefly illustrative of an approach to structuring variable interaction and control in designing a test for evaluation of the effectiveness of a minefield.

Effectiveness of a minefield has no meaning evaluated in a vacuum devoid of friendly-enemy interaction. This is true since any level of minefield potency can be achieved by increasing density if one is willing to expend the munition, personnel and time resources and cost to achieve it. A minefield is only effective/ineffective as a function of its contribution to friendly mission performance at an economically feasible level of employment/density. Consequently, the impact of the minefield on friendly mission performance becomes the operative variable which is allowed to run free, is measured, and the quantification of which becomes the measure of minefield effectiveness.

The operative variable of minefield effectiveness is then measured in a context of other randomized, constantized, and blocked out variables which are interwoven and constrained so that adequate statistical significance and reliability can be attached to results of testing. The infinite number of minefield variables of density and configuration (pattern, distribution, strips, depth) are first reduced to a spectrum or band of optimum/economically employable ones. The minefield density/configuration(s) employed in actual testing is then constantized at one or randomized using configurations from the reduced spectrum. A spectrum of terrain/vegetation conditions is determined and their influence randomized. An enemy-friendly force structure is selected based upon empirical data and constantized for the test. If test time/effort permit, these force structures may be randomly varied within a band of ratios; however, such an approach increases the number of replications required. Since probable enemy responses to a friendly force - minefield situation cannot be predicted reliably, the spectrum of relevant enemy responses is defined and reduced to those bearing upon minefield effectiveness. During testing iterations, these enemy responses are then varied randomly since they are basically unpredictable. Actual enemy and friendly movements, techniques, actions of crews, routes followed, etc., would be predetermined and constantized to preclude introduction of bias resulting from tactical judgment and leadership influences. The sizes of enemy and friendly forces involved in the evaluation is arrived at through a trade-off between the minimum force level at which breeching aids would be available and employed, accepted tactics are employable, and the maximum force levels which can be controlled to the rigid extent necessary and which the economics of sample size and cost make possible. The ideal compromise exists when an increase in enemy and friendly force levels would only have a linear effect on results due to the cellular nature of the enemy-friendly interaction, tactical techniques, etc.

Once the basic set of tests has been determined predicated on the minefield variables, the effort/time is compared to resources available to determine if they are realizable. If either time or materiel/personnel resources preclude the intended design, then the number and band width of variables introduced (force ratios, terrain types, etc.) must be traded-off against effective test design with a view toward reducing the number of tests. Beyond a mere trade-off of variables, limited worst/best case testing may enable identification and elimination of non-impacting individual variables and reduction of other variable "bands" such as mine density, terrain types, etc.

D. Introduction of Enemy Action

Test and evaluation of combat systems under conditions of enemy activity is the keystone of FFT of those systems. The missions of combat systems exist only as they relate to performance of a function(s) against or in connection with an enemy force or activity. A priori, that is why a combat system is what it is.

Tests of combat systems in the absence of enemy action are ultimately sterile. They can only produce results obtained in a testing vacuum, results which say something about the tested item in and of itself - parametrically or system-wise, but nothing about how these characteristics or performance parameters are muted or operative in the face of enemy action in the real world. Two different type tanks could exhibit 63 and 76 percent hit probabilities on a range against standard targets; yet, in the face of enemy action (non-live fire, instrumented duplication of actual firing) in multi-iterative enemy-friendly mission context engagements, not evince significant differences in MP/C. This could develop because other system impacts pursuant to target acquisition and engagement under conditions of enemy action could attenuate the parametric difference in hit probabilities.

The only arena in which MP/C can be truly tested in light of enemy action is combat. However, the constraints of the test environment only allow approximation of the combat environment as a limit. The realism of enemy action can be affected in varying degrees either through realistic target presentations in a live-fire context or through the use of equipment which allows opposing force interaction in a non-live fire setting. This equipment consequently must require performance of crew/operator duties while duplicating the performance capabilities of the armament.

Introduction of such realistic enemy-friendly interaction into the testing environment at the USAARENBD is made possible through the use of hit-kill indicators based on the commercially available SIMFIRE system. The SIMFIRE system as manufactured by the British corporation Solartron and modified by its United States representative, EMR Telemetry, is presently being considered for adoption by the Army as a training aid, designated as XM56, Hit-Kill Indicator. SIMFIRE is an electro-optic device which duplicates the ballistics of actual tank gun munitions. Since the ballistic characteristics of actual ammunition is simulated, the crew must apply both the proper superelevation and lead angles in addition to the proper sight picture to ensure a hit on the target. These three conditions are met only when all of the members of the crew perform their respective duties in the proper manner. Additionally, the target tanks are similarly equipped with SIMFIRE and hence able to "kill" the attacking tanks in return. Urgency motivation is thereby introduced into the exercise through the desire "to get him before he gets you." This sense of urgency, coupled with the fact that virtually all of the crewmembers must perform their crew duties in a precise fashion, stresses the man-machine system to its maximum in a quasi-combat environment.

SIMFIRE's main feature, its ability to ensure that all of the crewmembers must perform their respective, pertinent fire control duties quickly and accurately, is the basic feature needed in an instrumentation package to test combat vehicles in their intended mission roles. However, in the form it is commercially available, SIMFIRE only duplicates a few main armament systems, specifically, the British Chieftan Tank and the US M60A1 Tank. Because of this and other limitations, the basic SIMFIRE system had to be modified to duplicate a spectrum of direct-fire weapons mounted on a variety of vehicles, many of which are yet unknown. It is the modified form of SIMFIRE which is of interest in this paper, modifications which treble the original amount of electronics.

The additions to the basic SIMFIRE system are housed in one box and consist of the additional electronics needed to duplicate any tank main gun, antitank gun, any automatic weapon such as a 20MM automatic cannon, and any command guided missile such as TOW; in fact, any known direct fire weapon. Additional improvements to the original system include a rate sensing gyro to automatically calculate the proper lead angle and a probability of hit calculator to account for the numerous second order corrections that must be applied to the flight of a projectile. Because of safety considerations, high powered ruby lasers used in laser rangefinders (LRF) of many tanks cannot be used in two-sided testing, so provision was made to use the ranging capabilities of SIMFIRE as a substitute for those lasers. This enables the full capabilities of vehicles equipped with LRF's to be realized in exercises.

The modified SIMFIRE in its basic tank main gun/antitank gun configuration requires the following actions from the crew as appropriate. The tank commander first gives a fire command to coordinate actions of the crew. He then ranges to the target (using either LRF or coincidence rangefinder as appropriate to model). The driver will have to come smoothly to a stop. The gunner must index the proper ammunition in the computer and obtain the proper sight picture to include a proper lead if needed. Additionally, all of the fire control systems must, of course, be turned on and properly zeroed. The loader pushes a button to simulate loading of the round announced by tank commander and switches the gun from the safe to fire position. While the loader does not handle an actual round, he must be an active member of the crew, and the system has a built-in time delay to simulate the loading of a round. If all of the above is done properly, the tank will score a hit on the target, dependent, of course, on the dispersion characteristics of the ammunition/weapon system which is accounted for in the manner previously mentioned. In any case, the gunner will receive fall of shot information from the SIMFIRE system to enable him to re-lay on the target for a second shot, if necessary. The above only happens if the opposing vehicle does not get him first and disable his system, or if he is not out of ammunition.

At the heart of the SIMFIRE system is GaAs laser emitting radiation at approximately 9000 Å with a peak power of approximately 10 watts. The beam from this laser than traverses a set of lenses which diverges the beam to a preset width. The width of the beam, as detected by the threshold detectors of the system, remains at approximately a constant width from about 200 M out to about 2500 M. This is accomplished by selecting the divergence of the beam to yield a power flow outward from the center of the beam to exactly compensate for the power flow outward from the detection threshold points to keep these points at a constant spacing as the beam propagates through space.

The beam is further made to scan a region of space around the target. If the target is in the central portion of the scanned zone, then the weapon is said to be "on target." However, if the target is not in the central portion of the scanned zone, the weapon is said to be off target.

The shape of the central portion of the scanned zone or "kill zone" has the shape of a quadrilateral with rounded corners, the size and shape of which may be varied to suit the vulnerable areas of the target. While the kill zone does not duplicate in general the exact area which a target might be vulnerable, this quadrilateral shaped kill zone usually is a good approximation. It is close enough in fact to require the attacking crew to perform their duties as if the target's vulnerable areas were exactly duplicated by the kill zone.

When engaging a target, SIMFIRE goes through three distinct phases. The first phase it goes into from the standby phase is the Ranging Phase. In this phase, the system ranges to the target. In the second phase or the Fall of Shot Phase, a determination is made where an actual round would impact. Where an actual round would impact with relation to the line of sight is determined from the range information of Phase 1 and the ballistics data of the round selected by the loader. If the weapon is "on target" the system then informs the target that it is "dead" during the third or Kill Phase. The first and third phases take 1/2 second each while the second phase takes 1 second for a total of 2 seconds for a complete engagement. In its modified version, provision is made to cut all of these times in half.

The gunner is then required to hold a good sight picture for only 1/2 second; not an unrealistic requirement.

To simulate a high-powered LRF, the modified SIMFIRE just cycles through Phase 1 and feeds the range information into the fire control circuits of the tank thus eliminating only the high-powered laser. All of the remainder of the fire control system remains intact and functioning which forces the crew to perform all duties to score a hit.

To provide a differential of performance between those vehicles which have a sophisticated fire control computer such as the M60A1E3 and a standard tank such as the M60A1, a probability of hit calculator is employed to account for those numerous second order corrections which are considered by these systems. However, when utilizing such a scheme, it is vital to recognize during a test when the assumption that the corrections are second order in nature is no longer valid. Such instances are, for example, when extremely high velocity crosswinds exist or unusually high cant angles exist. Fortunately, this shortcoming of the SIMFIRE system may be overcome through proper test design.

The next form of the modified SIMFIRE system to be considered is the command guided missile configuration. After being fired by the gunner, the system first ranges to the target, then goes into the Fall of Shot Phase and remains there until the calculated moment of impact. It then goes into the third phase and "kills" the target, if appropriate. During the second or Fall of Shot Phase, the ability of the gunner to keep the simulated missile in the allowed flight envelope to the target is continuously monitored. If he ever deviates from this region, he is credited with a miss. In the design of the missile configuration of the modified SIMFIRE, the elliptic paraboloid which describes the allowed flight cone to the target is described to the system by a piecewise linear approximation. Also, heavy reliance was placed on the observed fact that the average velocity and lateral acceleration of all of the known operational command guided missiles are highly correlated. This is probably due to the fact that as technology improved, both the average velocity and lateral acceleration showed a corresponding improvement.

Those instabilities in the flight of a missile induced by trying to track a dodging target, which are due to the intrinsic time delay of the human tracker to react to a change of apparent motion of a target, are similarly an inherent part of the human-SIMFIRE missile simulator. As such, no additional "electronics" is needed to duplicate this type of instability.

While the missile simulator is not the most highly sophisticated system, it, when coupled with the probability of hit calculator, provides a most acceptable first order simulation of the flight of an actual missile.

In its last configuration, the automatic weapon configuration, the system first ranges to the target after being fired by the gunner, then it goes into the fall of shot mode. It is in this mode where it is determined whether the gunner applied the proper superelevation and deflection to hit the target. The gunner is in receipt of continuous fall of shot information to aid him in his aim. Naturally, the gunner must have set the actual fire control switches in the vehicle including the rate control switch, if present, to their proper positions before he engages the target. The natural dispersion of automatic weapons is accounted for by the probability of hit calculator which takes the rate of fire as well as the range into account to determine if target has been successfully engaged. Because a single round from an automatic weapon is not likely to destroy a vehicle, the gunner must remain on target long enough for a sufficient, preset number of rounds to have hit the target. Additionally, since many automatic weapons have a maximum lethal range, the gunner must engage a target within this maximum, preset range.

This configuration is a logical extension of the basic tank gun SIMFIRE system except that more than one "fall of shot" determination is made to account for the multiple rounds fired by automatic weapons.

When considering any simulation system using an analog, it must be remembered that by their very definition they are imperfect duplications. These shortcomings of the simulation device must be recognized, and through the proper design of the overall test, any limitations of the simulation scheme may be minimized.

E. Integration of Mission Reliability

Mission reliability has its most realistic, proper, and most effective impact through introduction as a degrading function vis-a-vis MP/C. If merely evaluated separately in a vacuum and then set off against MP/C and other measures, its impact becomes difficult if not impossible to place in perspective.

In the case of combat systems, the immediate impact of mission reliability (mission failure) is similar to a loss resulting from enemy action. Consequently, an effective means of allowing mission reliability to exercise its full "play" impact on a combat system is to integrate it with the actual demonstration of MP/C as an attritional factor in loss rate complementing that resulting from enemy action.

In the case of support systems, mission reliability can be permitted to impact directly on MP/C by using it to "knock out" support systems during their mission execution, thereby, leaving less systems available to accomplish the total mission. The procedure for degrading MP/C with reliability performance is normally a paper process, after testing is complete or sufficient reliability data gathered, and can be accomplished manually or by computer model depending upon the degree of sophistication of the FFT and evaluation.

RESULTS OF TECHNIQUES

The results from the use of the techniques discussed in this paper have been limited to early pilot tests involving the Add-On Stabilization System for M60A1 Tanks and the Mine Dispersing Subsystem for the XM56 Aircraft Delivered AntiTank Mine. Future major tests using these techniques include the Armored Reconnaissance Scout Vehicle and the M60A1E3 Tank Test.

In the M60A1 with Add-On Stabilization test, basic firing tests revealed that although the coaxial firing on the move was greatly improved, the main gun firing on the move was not as effective as had been hoped for. However, in SIMFIRE Functional Field Testing, although the test and comparison tank accomplished the mission in approximately the same number of instances, an important new piece of information was obtained. The test tank was able to minimize his time in a stationary position and was therefore "killed" only 16 times when fired on 52 times, while the comparison tank (M60A1) was "killed" 17 times in only 29 attempts. This information, not previously available, will give decision makers an improved perspective in determining if the improved capabilities outweigh the inherent increase in maintenance burden associated with an add-on device.

In the XM56 Mine Dispersing tests, functional tests involving tank vs tank engagements with and without a minefield, also provided previously unavailable information. In terms of the degree of mission accomplishment, it was found that a defending force was able to accomplish the defensive mission 18.8 percent of the time without the use of the minefield. However, with the use of a representative minefield (XM56) the defender was able to accomplish the defensive mission 62.5 percent of the time. It was also found that with the minefield in place, friendly losses were decreased by 29 percent and enemy losses were increased by 21 percent. These results were achieved with relatively low density, economical minefields. In previous mine testing, the individual mine was tested and evaluated. With functional field tests and SIMFIRE instrumentation, the minefield can be tested and evaluated in its employment environment.

From these results and the anticipated results of future tests, it is clear that this methodology/instrumentation concept will greatly enhance the evaluation of developmental materiel and will likewise provide valuable information to decision makers at all levels.

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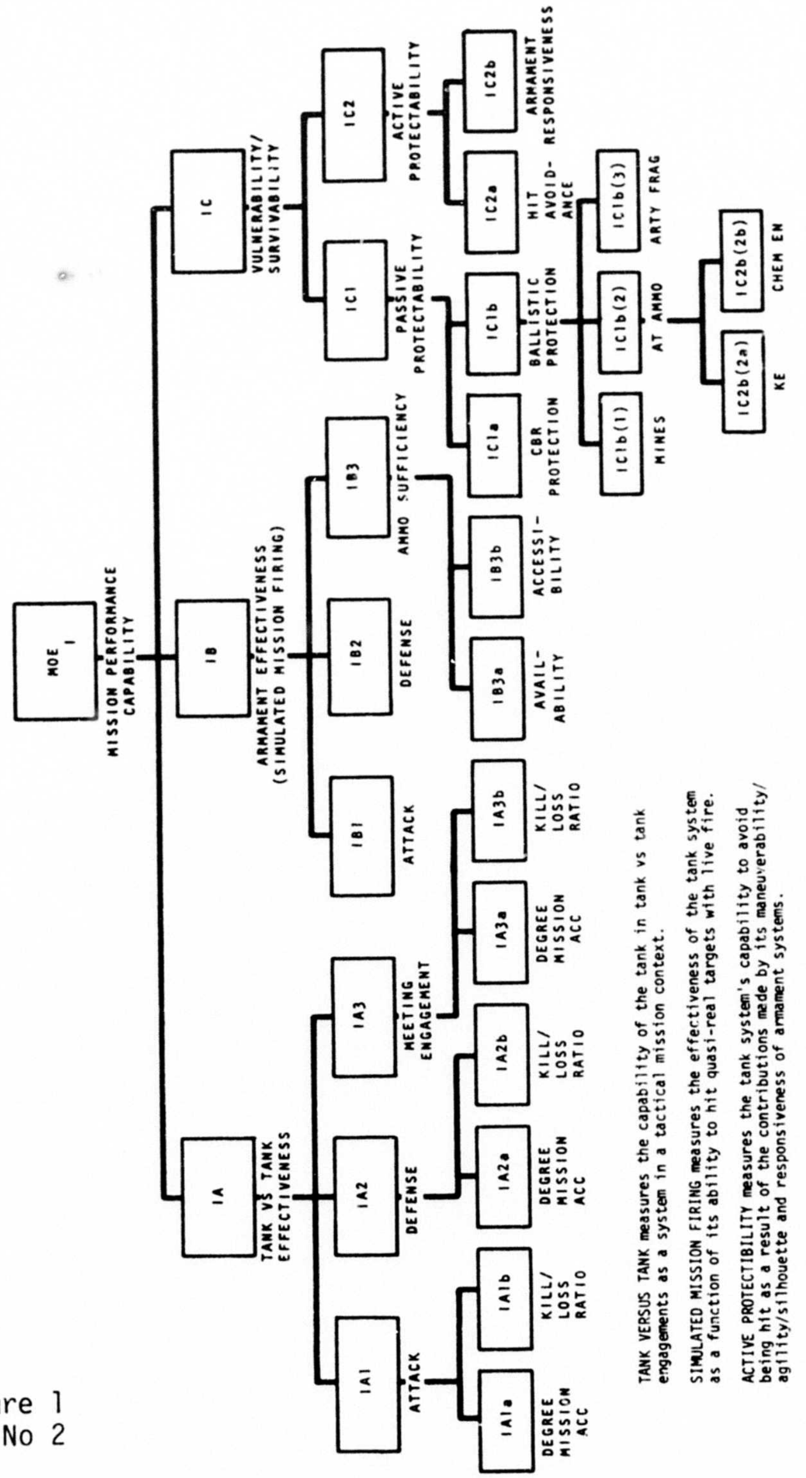

TANK VERSUS TANK measures the capability of the tank in tank vs tank engagements as a system in a tactical mission context.

SIMULATED MISSION FIRING measures the effectiveness of the tank system as a function of its ability to hit quasi-real targets with live fire.

ACTIVE PROTECTIBILITY measures the tank system's capability to avoid being hit as a result of the contributions made by its maneuverability/agility/silhouette and responsiveness of armament systems.

Inclosure 1
Figure No 2